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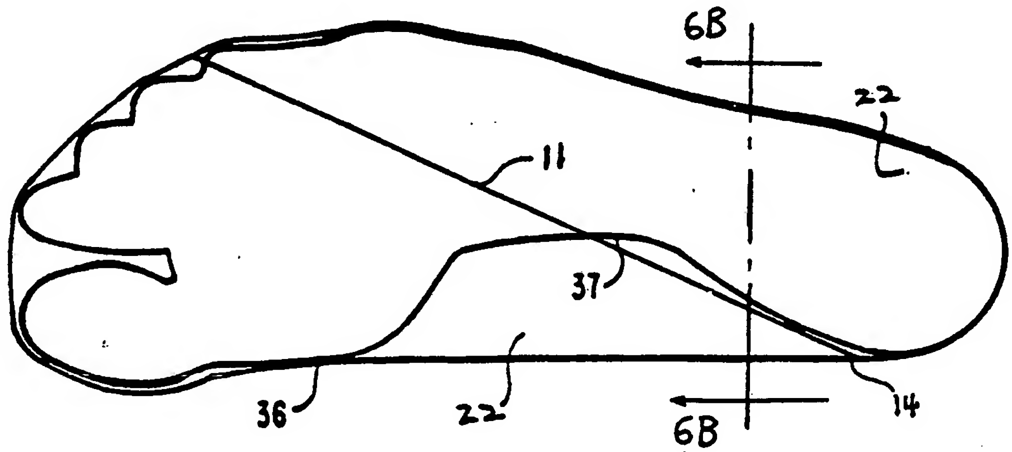
(54) Title: SHOE SOLE STRUCTURES



(57) Abstract

A construction for a shoe, specifically a shoe sole (22), particularly the structure of an athletic shoe sole. Still more particularly, this invention relates to a lateral stability sipe (11) that allows any shoe sole to provide significantly improved lateral support to the foot. Still more particularly, this invention relates to the use of a lateral stability sipe (11) in an athletic shoe sole (22) to provide it with sufficient flexibility along a natural axis so as to allow the shoe heel to remain relatively flat under the foot heel even when most of the forefoot of the shoe is lifted off the ground when tilted out sideways to a maximum in natural supination motion.

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SHOE SOLE STRUCTURES

BACKGROUND OF THE INVENTION

This invention relates generally to the structure of shoes, more specifically shoe soles. This invention relates particularly to the structure of athletic shoe soles. Still more particularly, this invention relates to a lateral stability sipe that allows any shoe sole to provide significantly improved lateral support to the foot. Still more particularly, this invention relates to the use of a lateral stability sipe in an athletic shoe sole to provide it with sufficient flexibility along a natural axis so as to allow the shoe heel to remain relatively flat under the foot heel even when most of the forefoot of the shoe is lifted off the ground when tilted out sideways to a maximum in natural supination motion.

The applicant has introduced into the art the use of sipes to provide natural deformation paralleling the human foot in pending U.S. application No. 07/424,509, filed October 20, 1989, No. 07/478,579, filed February 8, 1990, and No. 07/539,870, filed on June 18, 1990. It is the object of this invention to elaborate upon a specific form of sipe discussed generally in those earlier applications to apply some of their general principles to other shoe sole structures, including those introduced in other earlier applications.

In addition to the prior pending applications indicated

above, the applicant has introduced into the art the concept of a theoretically ideal stability plane as a structural basis for shoe sole designs. That concept as implemented into shoes such as street shoes and athletic shoes is presented in pending U.S. applications Nos. 07/219,387, filed on July 15, 1988; 07/239,667, filed on September 2, 1988; 07/400,714, filed on August 30, 1989; 07/416,478, filed on October 3, 1989; 07/463,302, filed on January 10, 1990; and 07/469,313, filed on January 24, 1990, as well as in PCT Application No. PCT/US89/03076 filed on July 14, 1989, and subsequent PCT Applications filed by the applicant.

Accordingly, it is a general object of the new invention to elaborate upon the application of the principle of the lateral stability sipe to conventional shoe sole structures.

It is an overall objective of this application to show additional forms and variations of the lateral stability sipe invention, particularly showing its incorporation into the other inventions disclosed in the applicant's other applications.

These and other objects of the invention will become apparent from a detailed description of the invention which follows taken with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a typical shoe, specifically an athletic running shoe known to the prior art to which the invention is applicable.

Fig. 2 shows, in frontal plane cross section at the heel,

the human foot when tilted 20 degrees outward, at the normal limit of ankle inversion.

Fig. 3 shows, in frontal plane cross section at the heel portion of a shoe, a conventional modern running shoe with rigid heel counter and reinforcing motion control device and a conventional shoe sole. Fig. 1 shows that shoe when tilted 20 degrees outward, at the normal limit of ankle inversion.

Fig. 4 show the footprints of the natural barefoot sole and shoe sole. Fig. 4A shows the foot upright with its sole flat on the ground; Fig. 4B shows the foot tilted out 20 degrees to about its normal limit; Fig. 4C shows a shoe sole of the same size when tilted out 20 degrees to the same position as Fig 4B. The right foot and shoe are shown.

Fig. 5 shows footprints like Figs. 4A and 4B of a right barefoot upright and tilted out 20 degrees, but showing also their actual relative positions to each other as a high arched foot rolls outward from upright to tilted out 20 degrees.

Fig. 6 shows the applicant's invention of a shoe sole with a lateral stability sipe in the form of a vertical slit. Fig. 6A is a top view of a conventional shoe sole with a corresponding outline of the wearer's footprint superimposed on it to identify the position of the lateral stability sipe relative to the wearer's foot. Fig. 6B is a cross section of the shoe sole with lateral stability sipe. Fig. 6C is a top view like Fig. 6A, but showing the print of the shoe sole with a lateral stability sipe when it is tilted outward 20 degrees.

Fig. 7 shows a medial stability sipe that is analogous to the lateral sipe, but to provide increased pronation stability; the head of the first metatarsal and the first phalange are included with the heel to form a medial support section.

Fig. 8 shows a footprints 37 and 17, like Fig. 5, of a right barefoot upright and tilted out 20 degrees, showing the actual relative positions to each other as a low arched foot rolls outward from upright to tilted out 20 degrees.

Fig. 9 shows pressure distribution measurements taken during running for a runner barefoot and with running shoes; Figs. 9 A & B were taken early in the load-bearing phase of the running stride and Figs. 9 C & D were taken late in the same phase; Figs. 9 A & C are of a right barefoot, while Figs. 9 B & D are with running shoe.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 shows a perspective view of a shoe, such as an athletic shoe in the form of a typical running shoe, according to the prior art, wherein the running shoe 20 includes an upper portion 21 and a sole 22.

Fig. 2 shows a similar heel cross section of a barefoot tilted outward laterally at the normal 20 degree inversion maximum. In marked contrast to Fig. 1, Fig. 2 demonstrates that such normal tilting motion in the barefoot is accompanied by a very substantial amount of flattening deformation of the human foot sole, which has a pronounced rounded contour when unloaded.

Fig. 2 shows that in the critical heel area the barefoot maintains almost as great a flattened area of contact with the ground when tilted at its 20 degree maximum as when upright.

Fig. 3 shows a conventional athletic shoe in cross section at the heel, with a conventional shoe sole 22. Fig. 3 specifically illustrates when that shoe is tilted outward laterally in 45 degrees of inversion motion, which is past the normal natural limit of such motion in the barefoot.

In complete contrast to the barefoot, Fig. 3 indicates clearly that the conventional shoe sole changes in an instant from an area of contact with the ground 43 substantially greater than that of the barefoot, as much as 100 percent more when measuring in roughly the frontal plane, to a very narrow edge only in contact with the ground, an area of contact many times less than the barefoot. The unavoidable consequence of that difference is that the conventional shoe sole is inherently unstable and interrupts natural foot and ankle motion, creating a high and unnatural level of injuries, traumatic ankle sprains in particular and a multitude of chronic overuse injuries.

This critical stability difference between a barefoot and a conventional shoe has been dramatically demonstrated in the applicant's new and original ankle standing sprain simulation test described in detail in the applicant's earlier U. S. patent application 07/400,714, filed on August 30, 1989 and was referred to also in both of his earlier applications previously noted here.

Fig. 3 demonstrates that the conventional shoe sole 22

functions as an essentially rigid structure in the frontal plane, maintaining its essentially flat, rectangular shape when tilted and supported only by its outside, lower corner edge 23, about which it moves in rotation on the ground 43 when tilted. The structural rigidity of most conventional street shoe materials alone, especially in the critical heel area, is usually enough to effectively prevent deformation, but they are often supplemented with strong heel counters and motion control devices.

Fig. 4 show the footprints of the natural barefoot sole and shoe sole. The footprints are the areas of contact between the bottom of the foot or shoe sole and the flat, horizontal plane of the ground, under normal body weight-bearing conditions. Fig. 4A shows a typical right footprint outline 37 when the foot is upright with its sole flat on the ground

Fig. 4B shows the footprint outline 17 of the same foot when tilted out 20 degrees to about its normal limit; this footprint corresponds to the position of the foot shown in Fig. 2. Critical to the inherent natural stability of the barefoot is that the area of contact between the heel and the ground is virtually unchanged, and the area under the base of the fifth metatarsal and cuboid is narrowed only sightly. Consequently, the barefoot maintains a wide base of support even when tilted to its most extreme lateral position.

The major difference shown in Fig. 4B is clearly in the forefoot, where all of the heads of the first through fourth metatarsals and their corresponding phalanges no longer make

contact with the ground. Of the forefoot, only the head of the fifth metatarsal continues to make contact with the ground, as does its corresponding phalange, although the phalange does so only slightly. The forefoot motion of the forefoot is relatively great compared to that of the heel.

Fig. 4C shows a shoe sole print outline of a shoe sole of the same size as the barefoot in Figs. 4A & 4B when tilted out 20 degrees to the same position as Fig 4B; this position of the shoe sole corresponds to that shown in Fig. 3. The shoe sole maintains only a very narrow bottom edge in contact with the ground, an area of contact many times less than the barefoot

Fig. 5 shows two footprints like footprint 37 in Fig. 4A of a barefoot upright and footprint 17 in Fig. 4B of a barefoot tilted out 20 degrees, but showing also their actual relative positions to each other as the foot rolls outward from upright to tilted out 20 degrees. The barefoot tilted footprint is shown hatched. The position of tilted footprint 17 so far to the outside of upright footprint 37 demonstrates the requirement for greater shoe sole width on the lateral side of the shoe to keep the foot from simply rolling off of the shoe sole; this problem is in addition to the inherent problem caused by the rigidity of the conventional shoe sole. The footprints are of a high arched foot.

Fig. 6 shows the applicant's invention of shoe sole with a lateral stability sipe 11 in the form of a vertical slit. The lateral stability sipe allows the shoe sole to flex in a manner that parallels the foot sole, as seen is Figs. 4 & 5. The lateral

stability sipe 11 allows the forefoot of the shoe sole to pivot off the ground with the wear's forefoot when the wearer's foot rolls out laterally. At the same time, and most critically, it allows the remaining shoe sole to remain flat on the ground under the wearer's load-bearing tilted footprint 17 in order to provide a firm and natural base of structural support to the wearer's heel, his fifth metatarsal base and head, as well as cuboid and fifth phalange and associated softer tissues. In this way, the lateral stability sipe provides the wearer of even a conventional shoe sole with lateral stability like that of the barefoot. All shoes can be distinctly improved with this invention, even women's high heeled shoes.

With the lateral stability sipe, the natural supination of the foot, which is its outward rotation during load-bearing, can occur with greatly reduced obstruction. The functional effect is analogous to providing a car with independent suspension, with the axis aligned correctly. At the same time, the principle load-bearing structures of the foot are firmly supported with no sipes directly underneath.

Fig. 6A is a top view of a conventional shoe sole with a corresponding outline of the wearer's footprint superimposed on it to identify the position of the lateral stability sipe 11, which is fixed relative to the wearer's foot, since it removes the obstruction to the foot's natural lateral flexibility caused by the conventional shoe sole.

With the lateral stability sipe 11 in the form of a

vertical slit, when the foot sole is upright and flat, the shoe sole provides firm structural support as if the sipe were not there. No rotation beyond the flat position is possible with a sipe in the form of a slit, since the shoe sole on each side of the slit prevents further motion.

Many variations of the lateral stability sipe 11 are possible to provide the same unique functional goal of providing shoe sole flexibility along the general axis shown in Fig. 6. For example, the slit can be of various depths depending on the flexibility of the shoe sole material used; the depth can be entirely through the shoe sole, so long as some flexible material acts as a joining hinge, like the cloth of a fully lasted shoe, which covers the bottom of the foot sole, as well as the sides. The slits can be multiple, in parallel or askew. They can be offset from vertical. They can be straight lines, jagged lines, curved lines or discontinuous lines.

Although slits are preferred, other sipe forms such as channels or variations in material densities as described in the applicant's earlier '509, '579, and '870 applications can also be used, though many such forms will allow varying degrees of further pronation rotation beyond the flat position, which may not be desirable, at least for some categories of runners. Other methods in the existing art can be used to provide flexibility in the shoe sole similar to that provided by the lateral stability sipe along the axis shown in Fig. 6.

The axis shown in Fig. 6 can also vary somewhat in the

horizontal plane. For example, the footprint outline 37 shown in Fig. 6 is positioned to support the heel of a high arched foot; for a low arched foot tending toward excessive pronation, the medial origin 14 of the lateral stability sipe would be moved forward to accommodate the more inward or medial position of pronator's heel. The axis position can also be varied for a corrective purpose tailored to the individual or category of individual: the axis can be moved toward the heel of a rigid, high arched foot to facilitate pronation and flexibility, and the axis can be moved away from the heel of a flexible, low arched foot to increase support and reduce pronation.

It should be noted that various forms of firm heel counters and motion control devices in common use can interfere with the use of the lateral stability sipe by obstructing motion along its axis; therefore, the use of such heel counters and motion control devices should be avoided.

The lateral stability sipe may also compensate for shoe heel-induced outward knee cant.

Fig. 6B is a cross section of the shoe sole 22 with lateral stability sipe 11. The shoe sole thickness is constant but could vary as do many conventional and unconventional shoe soles known to the art. The shoe sole could be conventionally flat like the ground or conform to the shape of the wearer's foot, as introduced in the applicant's '667 application and subsequent applications.

Fig. 6C is a top view like Fig. 6A, but showing the print

of the shoe sole with a lateral stability sipe when the shoe sole is tilted outward 20 degrees, so that the forefoot of the shoe sole is not longer in contact with the ground, while the heel and the lateral section do remain flat on the ground.

Fig. 7 shows a conventional shoe sole with a medial stability sipe 12 that is like the lateral sipe 11, but with a purpose of providing increased medial or pronation stability instead of lateral stability; the head of the first metatarsal and the first phalange are included with the heel to form a medial support section inside of a flexibility axis 12. The medial stability sipe 12 can be used alone, as shown, or together with the lateral stability sipe 11, which is not shown.

Fig. 8 shows a footprints 37 and 17, like Fig. 5, of a right barefoot upright and tilted out 20 degrees, showing the actual relative positions to each other as a low arched foot rolls outward from upright to tilted out 20 degrees. The low arched foot is particularly noteworthy because it exhibits a wider range of motion than the Fig. 5 high arched foot, so the 20 degree lateral tilt footprint 17 is farther to the outside of upright footprint 37. In addition, the low arched foot pronates inward to inner footprint borders 18; the hatched area 19 is the increased area of the footprint due to the pronation, whereas the hatch area 16 is the decreased area due to pronation.

In Fig. 8, the lateral stability sipe 11 is clearly located on the shoe sole along the inner margin of the lateral footprint 17 superimposed on top of the shoe sole and is straight

to maximize ease of flexibility.

A shoe sole of extreme width is necessitated by the common foot tendency toward excessive pronation, as shown in Fig. 8, in order to provide structural support for the full range of natural foot motion, including both pronation and supination. Extremely wide shoe soles are most practical if the sides of the shoe sole are not flat as is conventional but rather are bent up to conform to the natural shape of the shoe wearer's foot sole in accordance with the applicant's '667 and later pending applications.

Fig. 9 shows pressure distribution measurements taken during running for a runner barefoot and with running shoes. Figs. 9 A & C are of a right barefoot, while Figs. 9 B & D are with running shoe.

Figs. 9 A & B were taken early in the load-bearing phase of the running stride and the areas of pressure shown coincide with the area encompassed by the lateral tilt footprint 17. Figs. 9 C & D were taken late in the same phase and the areas of pressure shown occur in the remaining load-bearing portion of the footprint area 37. Both sets of Figs. coincide with general areas of peak loads focused on specific points, which would tend to unbalance the shoe sole. It is anticipated that the lateral stability sipe invention will serve to reduce these peak point loads by better distributing the pressure to broader areas, increasing stability thereby. Since the lateral stability sipe is not located underneath the two areas of peak pressure points, but rather

between them, it should be able to provide firm structure support to those areas, so that the functional characteristics of existing conventional shoe soles is not alterred a great deal, except as intended by the invention.

Note that the head of the fifth metatarsal and the fifth phalange are functionally part of both areas and are the only structural elements of the foot that are mutual to both areas.

Finally, although not shown, the design of shank support should be modified according to the applicant's invention, so that natural flexibility along the axis of the lateral stability sipe 11 is provided, instead of obstructed, as do existing shank designs.

The foregoing shoe designs meet the objectives of this invention as stated above. However, it will clearly be understood by those skilled in the art that the foregoing description has been made in terms of the preferred embodiments and various changes and modifications may be made without departing from the scope of the present invention which is to be defined by the appended claims.

WHAT IS CLAIMED IS:

1. A shoe construction for a shoe, such as an athletic shoe, comprising:

an conventional upper shoe and a conventional shoe sole;

said shoe sole having a lateral stability sipe or sipes such as slits or channels originating from the bottom surface of said sole;

said sipe or sipes being of sufficient shape, size, depth, orientation and number to provide said shoe sole with flexibility sufficiently similar to that of the sole of the wearer's foot, so as to allow the shoe heel to remain relatively flat under the foot heel even when most of the forefoot of the shoe is lifted off the ground when tilted out sideways to a maximum in natural supination motion.

2. The shoe sole construction as set forth in claim 1, wherein said shoe sole has a heel thickness greater than the forefoot thickness.

3. The shoe sole construction as set forth in claim 2, wherein said lateral stability sipe is a single slit.

4. The shoe sole construction as set forth in claim 3, wherein said lateral stability sipe is vertical.

5. The shoe sole construction as set forth in claim 4, wherein said lateral stability sipe penetrates most of the thickness of said shoe sole.

6. The shoe sole construction as set forth in claim 4, wherein said lateral stability sipe penetrates all of the thickness of said shoe sole except for a flexible connecting material such as fabric which functions as a hinge.

7. The shoe sole construction as set forth in claim 4, wherein said lateral stability sipe is straight.

8. The shoe sole construction as set forth in claim 5, wherein said lateral stability sipe originates on the medial side of said shoe sole immediately in front of the wearer's heel and terminates on the lateral side immediately in front of the wearer's fifth phalange.

9. The shoe sole construction as set forth in claim 1, wherein said shoe sole under the base and head of the fifth metatarsal, and the cuboid remain flat on the ground when the wearer's foot is tilted out laterally to its natural maximum.

10. The shoe sole construction as set forth in claim 9, wherein said shoe sole remaining flat include the fifth phalange.

11. The shoe sole construction for a shoe, such as a street or athletic shoe, comprising:

a sole having a substantially flat sole portion including a foot support surface, a naturally contoured side portion merging with at least a medial and/or lateral heel portion of said sole portion and conforming substantially to the shape of the associated sides of the human foot sole, and a substantially uniform frontal plane thickness;

said thickness being defined as about the shortest distance between any point on an upper, foot-contacting surface of said shoe sole and a lower, ground-contacting surface;

said thickness varying in about the sagittal plane and being greater in the heel portion than in the forefoot;

said thickness of the naturally contoured side portion about equaling and therefore varying substantially directly with the thickness of the sole portion in about the frontal plane;

said shoe sole composed of material of normal shoe sole firmness;

said shoe sole having a lateral stability sipe or sipes such as slits or channels originating from the bottom surface of said sole;

said sipe or sipes being of sufficient shape, size, depth, orientation and number to provide said shoe sole with flexibility sufficiently similar to that of the sole of the wearer's foot, so as to allow the shoe heel to remain relatively flat under the foot heel even when most of the forefoot of the shoe is lifted off the

ground when tilted out sideways to a maximum in natural supination motion.

12. The shoe sole construction as set forth in claim 11, wherein said shoe sole has a heel thickness greater than the forefoot thickness.

13. The shoe sole construction as set forth in claim 12, wherein said lateral stability sipe is a single slit.

14. The shoe sole construction as set forth in claim 13, wherein said lateral stability sipe is vertical.

15. The shoe sole construction as set forth in claim 14, wherein said lateral stability sipe penetrates most of the thickness of said shoe sole.

16. The shoe sole construction as set forth in claim 14, wherein said lateral stability sipe penetrates all of the thickness of said shoe sole except for a flexible connecting material such as fabric which functions as a hinge.

17. The shoe sole construction as set forth in claim 14, wherein said lateral stability sipe is straight.

18. The shoe sole construction as set forth in claim 15,

wherein said lateral stability sipe originates on the medial side of said shoe sole immediately in front of the wearer's heel and terminates on the lateral side immediately in front of the wearer's fifth phalange.

19. The shoe sole construction as set forth in claim 11, wherein said shoe sole under the base and head of the fifth metatarsal, and the cuboid remain flat on the ground when the wearer's foot is tilted out laterally to its natural maximum.

20. A shoe construction for a shoe, such as an athletic shoe, comprising:

an conventional upper shoe and a conventional shoe sole;

said shoe sole having a medial stability sipe or sipes such as slits or channels originating from the bottom surface of said sole;

said sipe or sipes being of sufficient shape, size, depth, orientation and number to provide said shoe sole with flexibility sufficiently similar to that of the sole of the wearer's foot, so as to allow the shoe heel to remain relatively flat under the foot heel even when most of the forefoot of the shoe is lifted off the ground when tilted in sideways to a maximum in natural pronation motion

Said shoe sole wherein a medial stability sipe originates on the lateral side of said shoe sole immediately in front of the wearer's heel and terminates on the lateral side immediately in front of the wearer's first phalange

FIG. 1
(PRIOR ART)

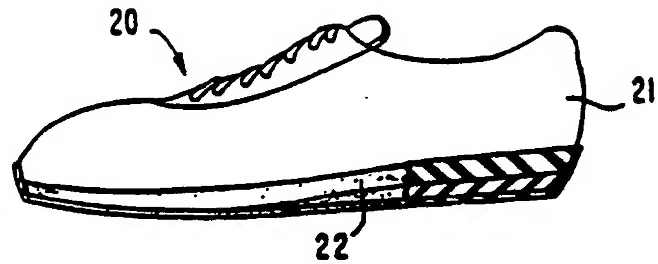


FIG. 2

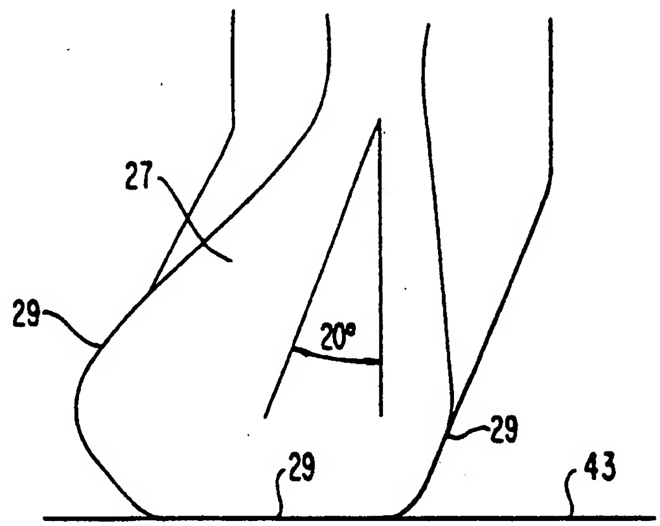


FIG. 3

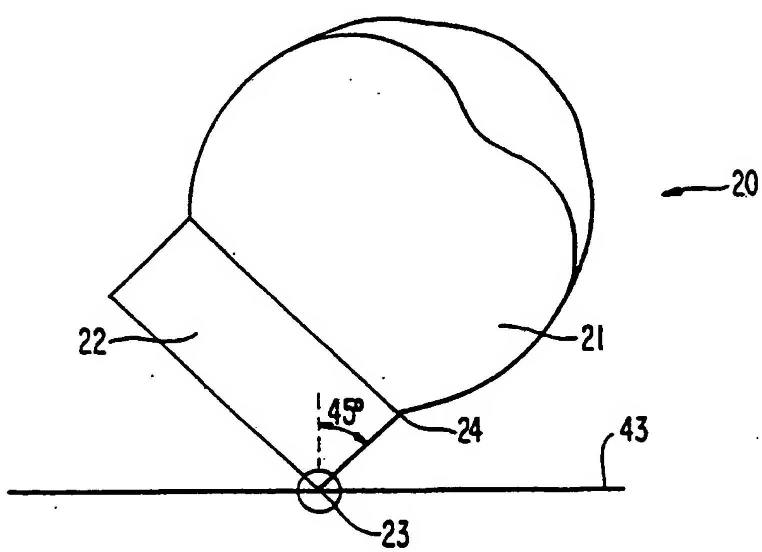
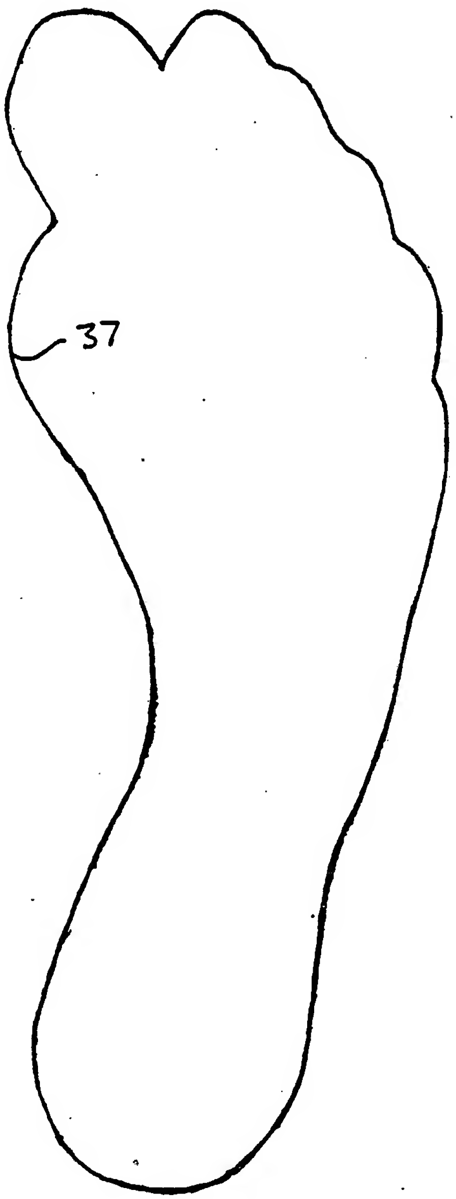


Fig. 4 FOOTPRINTS

Fig. 4A



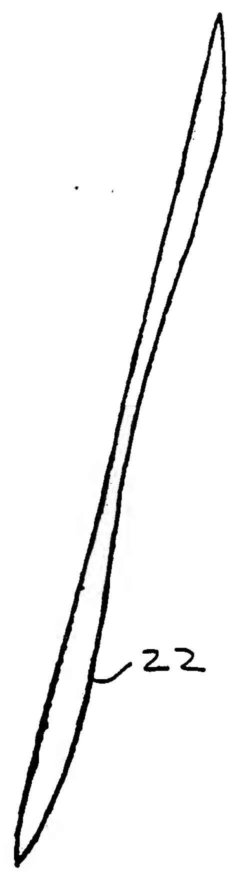
Flat

Fig. 4B

BAREFOOT

Fig. 4C

SHOE SOLE



Tilted Out 20°

Fig. 5

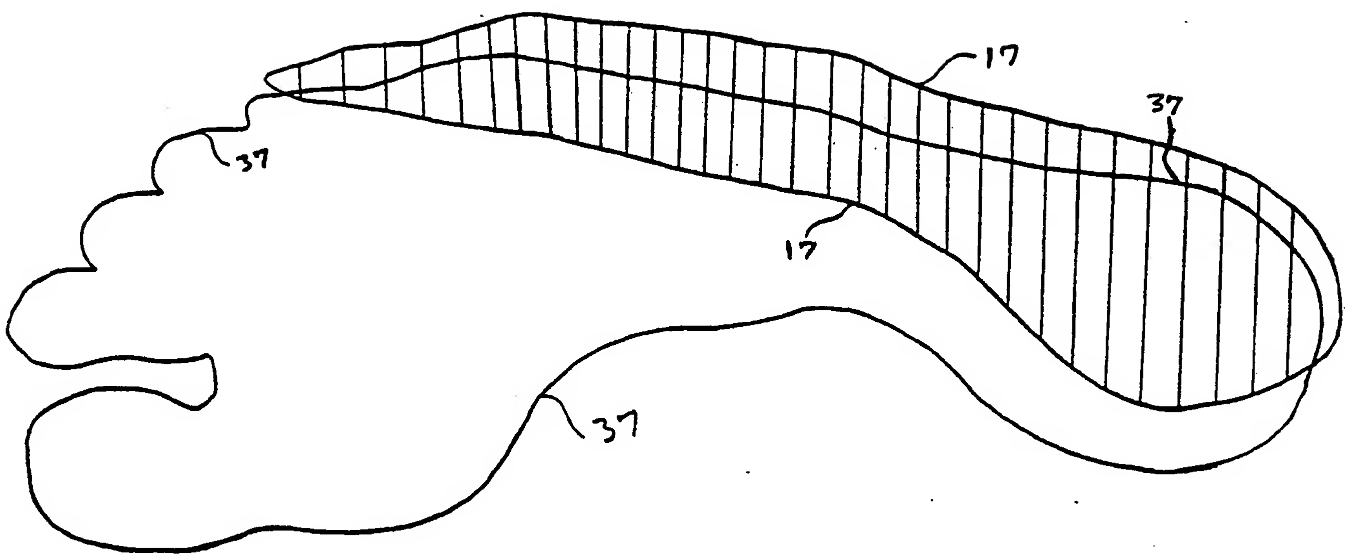


Fig. 6B

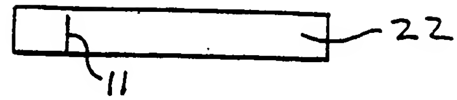
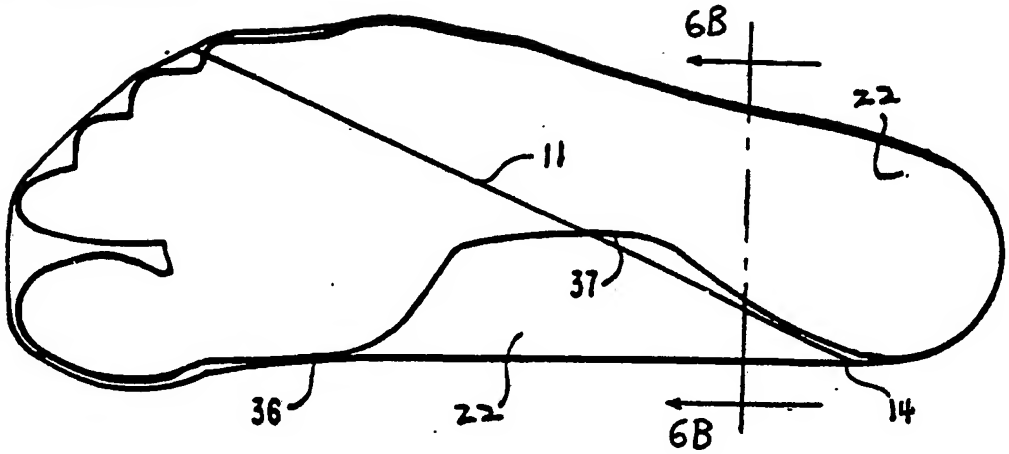


FIG. 6A



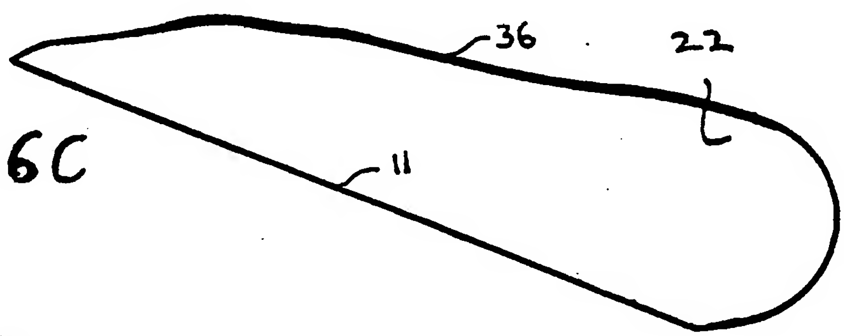


Fig. 6C

FIG. 7

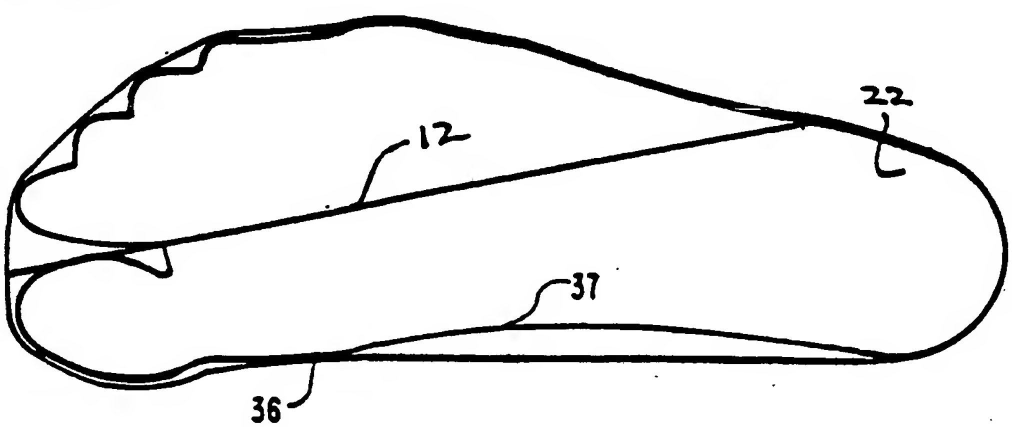


Fig. 8

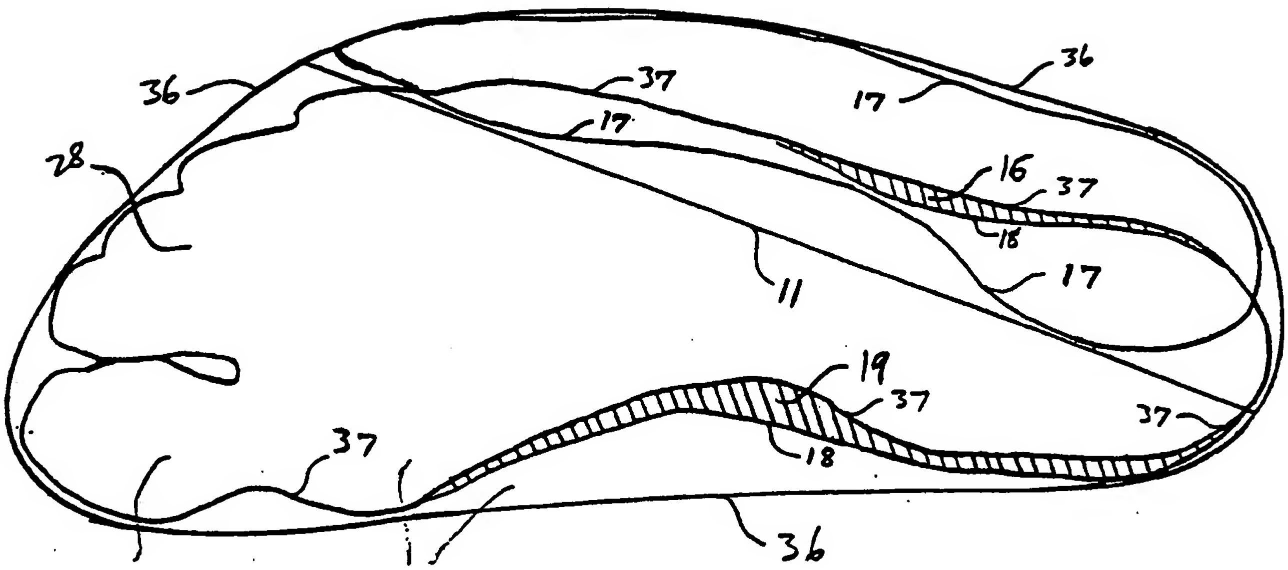
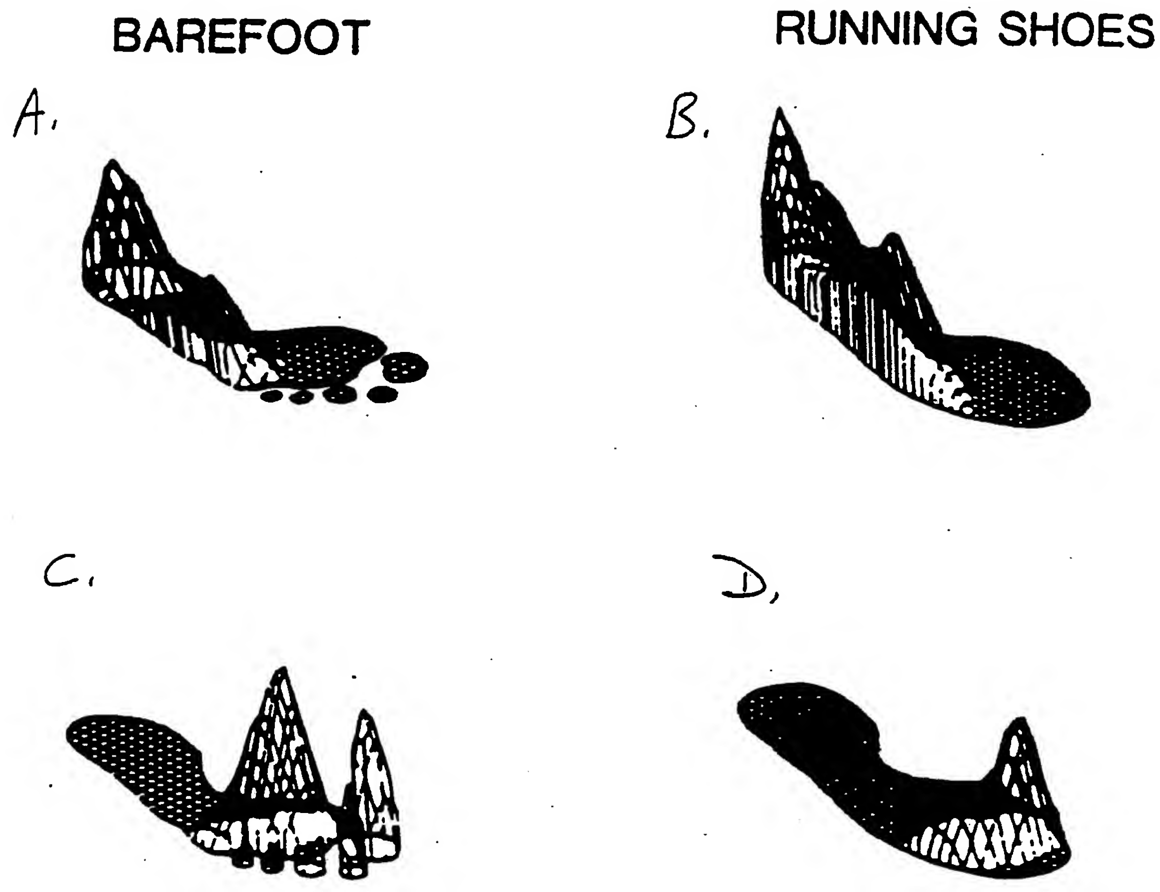


Fig. 9



Pressure distribution measurements during running

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/07944

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC
US. CL.: 36/25R, 59C, 32A
INT CL(5): A43B 13/00

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U. S.	36/32A, 31, 59C, 102, 28, 59R, 25R, D2/320,309,310

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No [13]
X	US, A, D 86,527 KLEIN 15 MARCH 1932 (Figs. 1-2).	1,9-10,20
X / Y	US, A, 2,162,912 CRAVER 20 JUNE 1939 See entire document.	1-4,7, 9-10 / 5-6,8,11-19
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* Special categories of cited documents: [10]
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
01 FEBRUARY 1992	21 FEB 1992

International Searching Authority	Signature of Authorized Officer
ISA/US	NGOC-HO INTERNATIONAL DIVISION For STEVEN N. MEYERS Ngoc-Ho Nguyen

Form PCT/ISA/210 (second sheet) (Rev.11-87)

FURTHER INFORMATION CONTINUED FROM THE SECOND SHEET

A	US, A, 4,864,739 MAESTRI 12 SEPTEMBER 1989	
A	US, A, 5,012,597 THOMASSON 7 MAY 1991	

V ☐ OBSERVATIONS WHERE CERTAIN CLAIMS WERE FOUND UNSEARCHABLE [1]

This international search report has not been established in respect of certain claims under Article 17(2) (a) for the following reasons

1. ☐ Claim numbers because they relate to subject matter [12] not required to be searched by this Authority, namely:

2. ☐ Claim numbers , because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out [13], specifically:

3. ☐ Claim numbers___________, because they are dependent claims not drafted in accordance with the second and third sentences of PCT Rule 6.4(a).

VI. ☐ OBSERVATIONS WHERE UNITY OF INVENTION IS LACKING [2]

This International Searching Authority found multiple inventions in this international application as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims of the international application.
2. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims of the international application for which fees were paid, specifically claims:
3. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claim numbers:
4. ☐ As all searchable claims could be searched without effort justifying an additional fee, the International Searching Authority did not invite payment of any additional fee.

Remark on Protest

☐ The additional search fees were accompanied by applicant's protest.

☐ No protest accompanied the payment of additional search fees.